Adaptive Sensor Fleet (ASF) Overview

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PRESENTATION VERSION

NOTE: Operational scenario examples are intended to be viewed as a slide show due to the use of custom animations (PowerPoint 2002)

Agenda

- Project Overview
- Functional Architecture
- Operational Scenarios
- Project Information

Project Overview

Team Members:

- Rodger Abel, Code 583 (System Engineer/Requirements/Science Goal Analyzer)
- Kara Chapman, Code 586 (Platform Simulator/Platform Descriptions)
- Pat Hennessy, Code 584 (Fleet Management Integration/System Support)
- Jeff Hosler, Code 588 (Project Lead/System Engineer/Science Goal Analyzer)
- Mark Lupisella, Code 584 (Consultant/Risk)
- David McComas, Code 582 (Platform Simulator)
- Andrew Mitchell, Code 589.W (XML Support)
- Pamela Pittman, Code 589.W (User Interface Support/Goal Definition)
- Corinne Reed-Miller, Code 585 (User Interface/Goal Definition)
- Tom Sardella, Code 583 (Platform Proxy)
- Eric Stoneking, Code 591 (Fleet Management)
- Troy Ames, Code 588 (IRC/Consultant)
- John Moisan, Code 972 (OASIS PI)

Project Overview (cont.)

ASF Project Goals:

- Demonstrate goal-oriented commanding to autonomously task and control a fleet of instruments and sensors, and respond to a dynamic environment
- Allow scientists to optimally plan observations, and conduct "what if" scenarios, in a simulated environment
- Lay the foundation for a dynamic "Sensor Web" using stationary, surface moving (water or land), airborne, and spacecraft instruments to generate a dynamic network of sensors to achieve the science goals

Project Overview (cont.)

Test Domain:

- The Ocean-Atmosphere Sensor Integration System (OASIS) project being developed at Wallops will be our target application domain.
  - Platforms are autonomous water-craft that house instrumentation for measurements
  - Infrastructure for communicating and controlling the platforms has been demonstrated, and will be completed this Fiscal Year (FY04) using the Instrument Remote Control (IRC)
- A Fleet of three (3) Platforms will be used for demonstration

Operational Scenarios

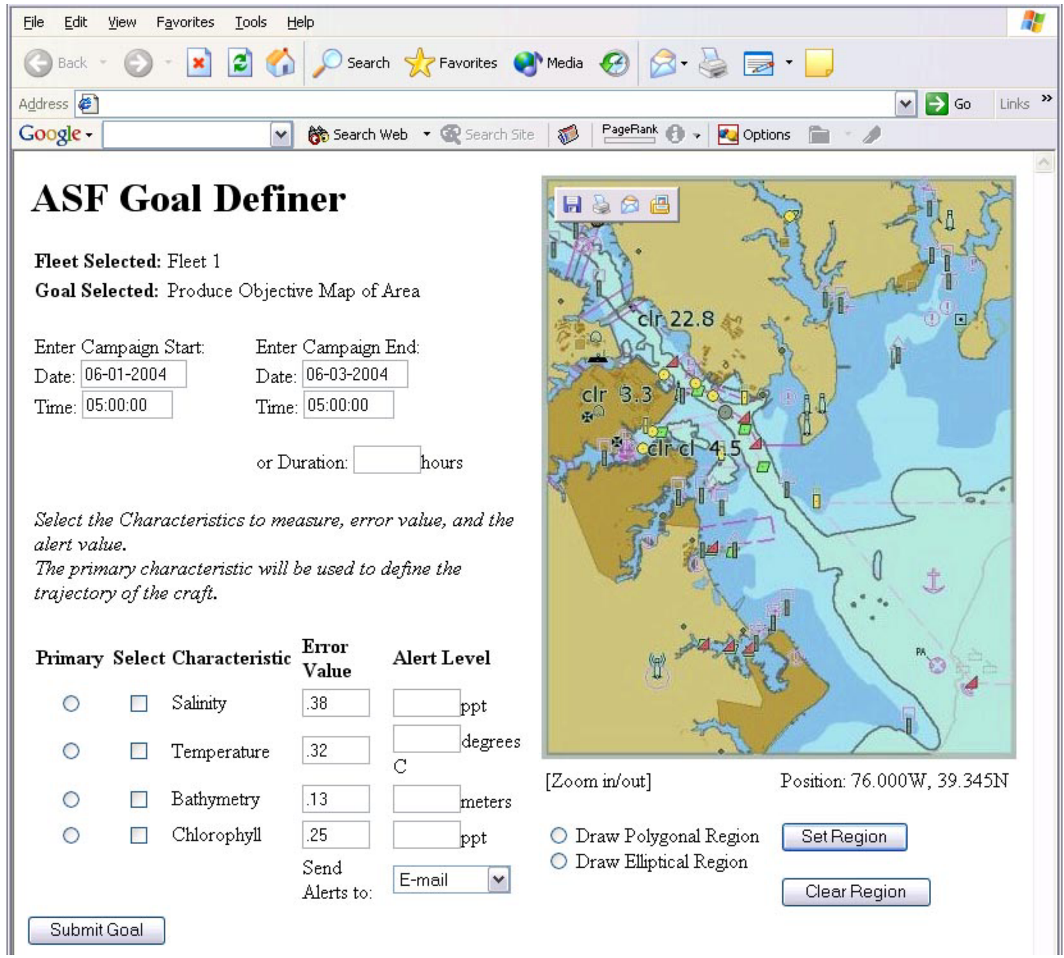
- The following two Operational Scenarios describe a conceptual overview of our Phase A and Phase B demonstrations.
  - Dynamic “Region” Mapping
    - User defines a high-level goal to initiate system processing
    - ASF will use multiple platforms to collect specific science measurements over a defined region to build a science model of the region, i.e. surface temperature
    - Measurements are collected in the Science/Goal Analyzer, and evaluated to not only ensure the goal is being satisfied, but to determine where areas of high concentration levels exist (where higher errors in the model will occur)
    - Changes are dynamically sent to the Fleet Manager where the Platforms are focused in the critical areas to minimize model error
  - Dynamic “Feature” Mapping
    - User defines a high-level goal to initiate system processing
    - ASF will use multiple platforms to locate specific science measurements in a defined region to build a science model of a feature, i.e. algae
    - Measurements are collected in the Science/Goal Analyzer, and evaluated to locate the feature as defined by the goal
    - When the feature is located, the Fleet Manager is notified to begin the mapping of the feature. Platforms are used to optimally map the desired feature

NOTE: Detailed operational scenarios can be located within the ASF Use Case Scenarios Document.

Operational Scenarios
Dynamic Region Mapping Goal Definition

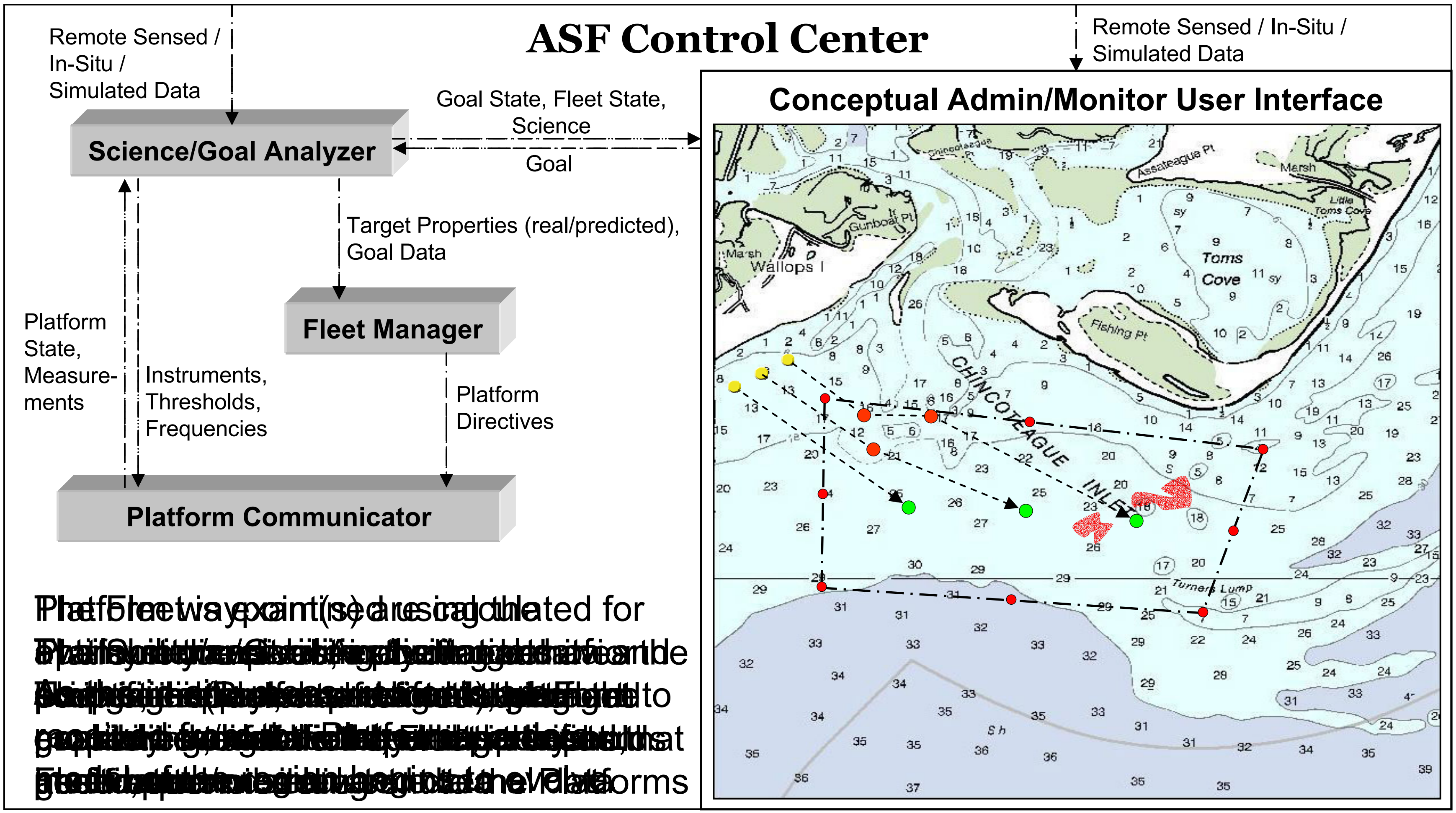
Goal definition:

- User specifies when the campaign will start and end
- User specifies the measurements (with error tolerance) to be modeled
- User selects the region to be modeled by specifying coordinates, or selecting a region on a world map. The relevant navigation chart(s) are dynamically obtained from a NOAA data store and displayed.
- User submits the goal



Operational Scenarios

Collaborative Multi-Platform Region Mapping

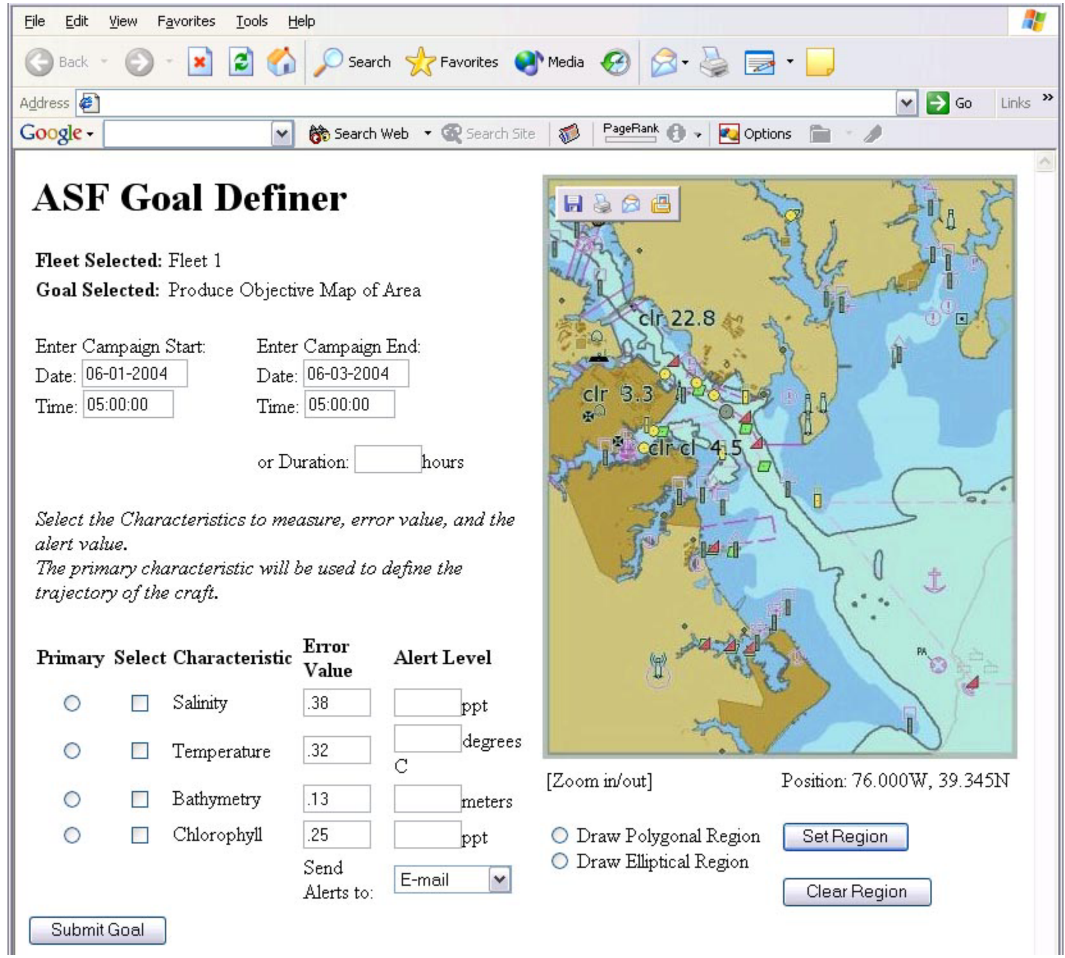


Operational Scenarios

Dynamic Region Mapping Goal Definition

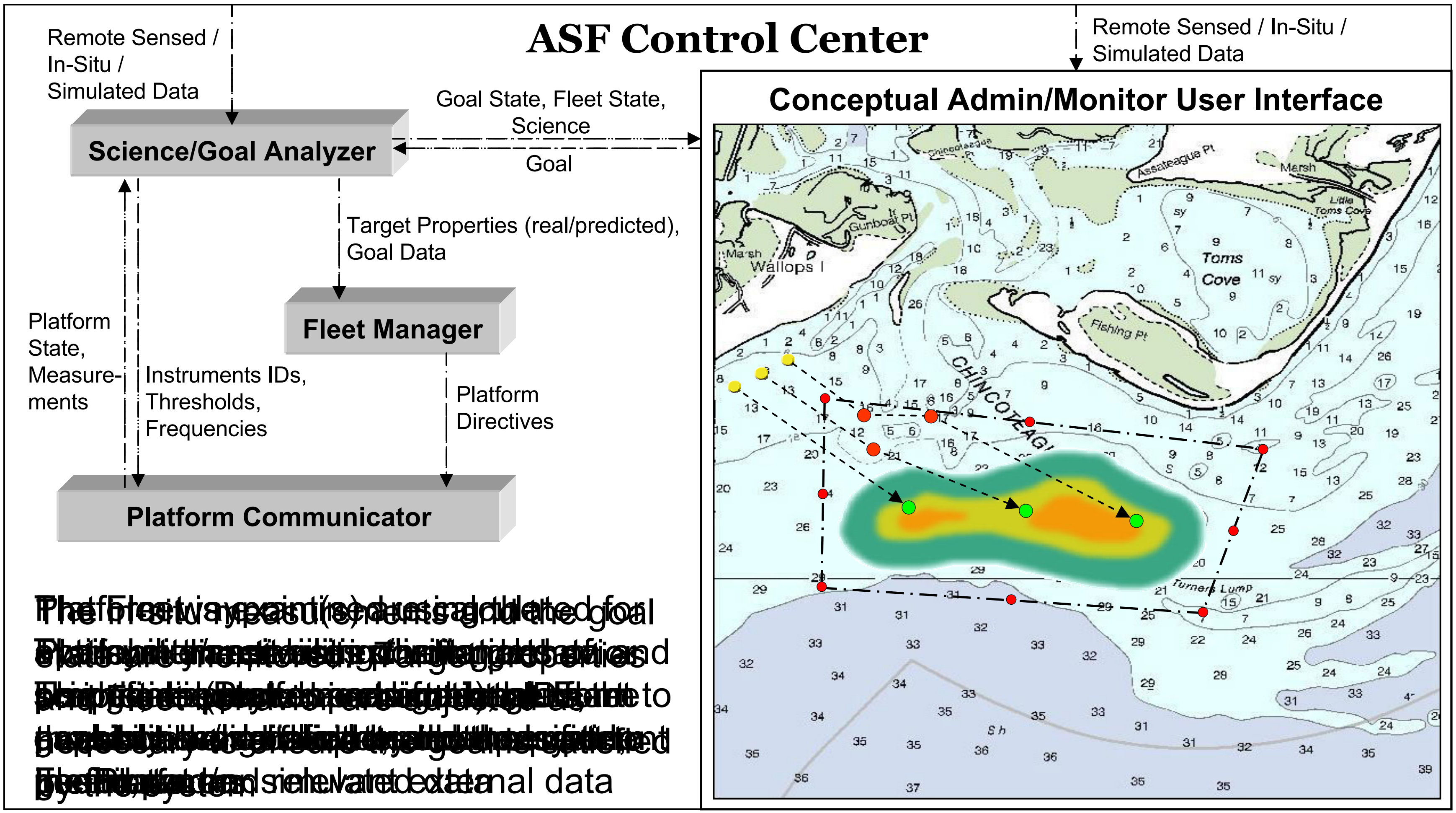
Goal definition:

- User specifies when the campaign will start and end
- User specifies the measurements (with error tolerance) to be dynamically located
- User selects the region of interest to be modeled by specifying coordinates, or selecting a region on a world map. The relevant navigation chart(s) are dynamically obtained from a NOAA data store and displayed.
- User submits the goal

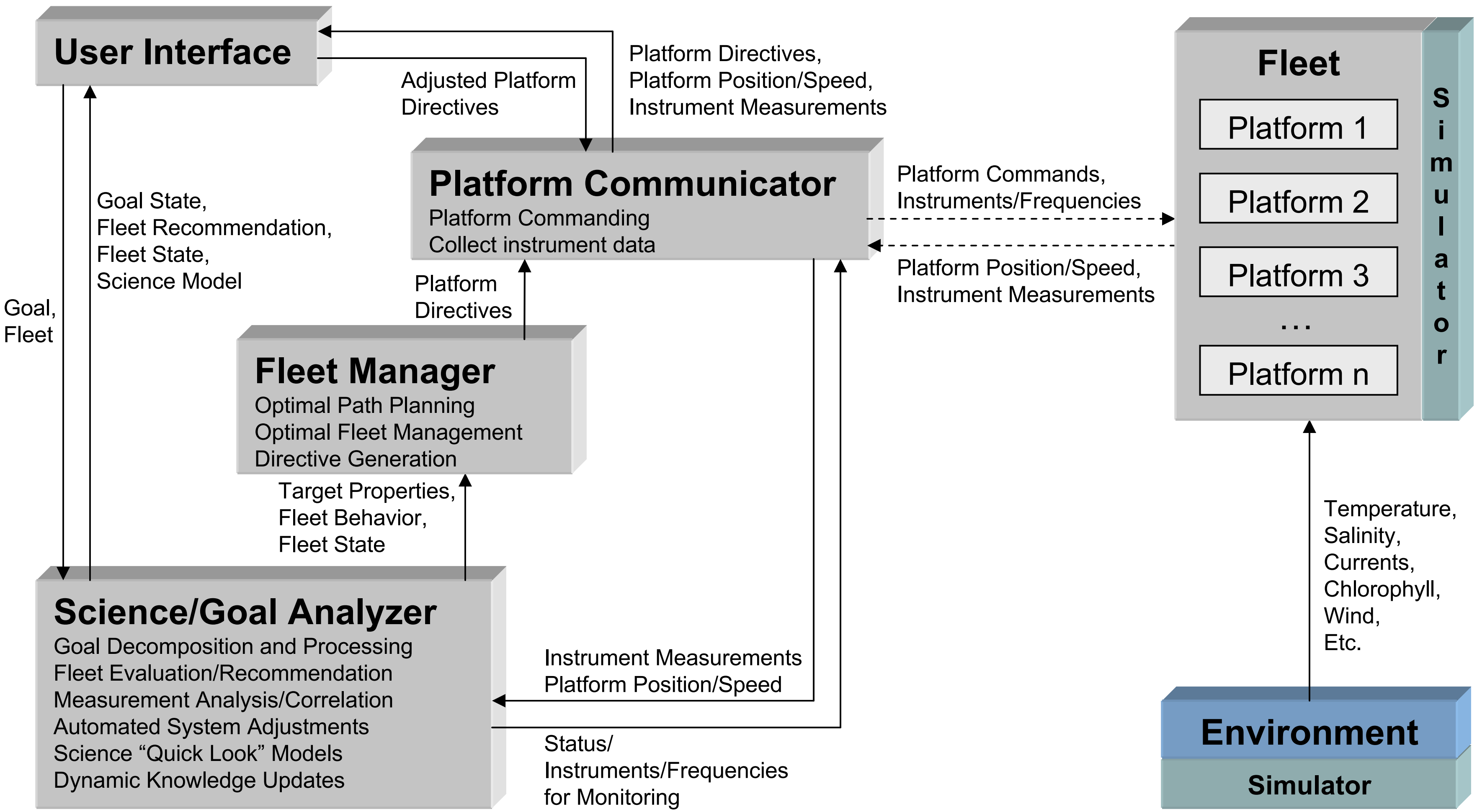


Operational Scenarios

Collaborative Multi-Platform Feature Mapping



Functional Architecture



Functional Architecture (cont.)

- User Interface
  - Provides an interactive method for defining and monitoring science goals
  - Provides the ability to administer and monitor the Fleet
  - Provides the ability to set up simulations
  - Provides the ability to monitor the ASF system elements
  - Obtains static environmental knowledge as it pertains to the goal
- Science/Goal Analyzer
  - Performs high-level goal decomposition and processing
  - Provides the user a Fleet make-up recommendation based upon the goal decomposition (additionally ensures the Fleet can satisfy the goal)
    - Minimum fleet
    - Optimal fleet
  - Analyzes and correlates science measurements to force automated system adjustments to ensure the goal is being achieved
    - Dynamically requests information (science and status) from the Platforms to monitor the goal state and uses the information to make system adjustments
    - Generates real-time science "quick-look" models
    - Integrates predictive models
  - Dynamically updates environmental knowledge based upon science values received from the Platforms

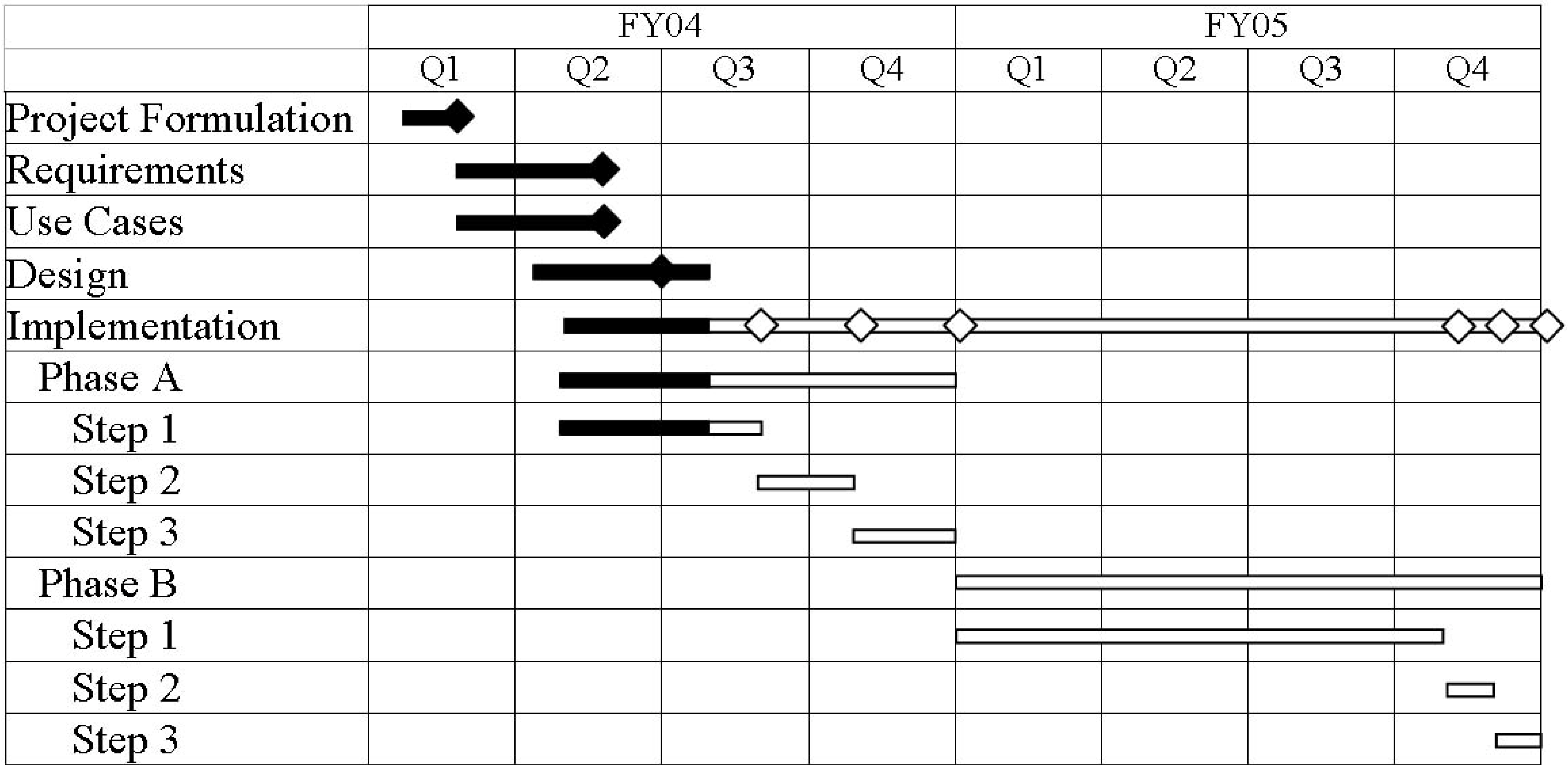
Functional Architecture (cont.)

- Fleet Manager
  - Defines the behavior of individual Platforms to optimally satisfy goal requirements
  - Performs path planning using environmental knowledge to ensure the most efficient path to get from one location to another
  - Optimally uses all platforms in the Fleet to achieve the goal requirements
    - “Search” algorithms
    - “Mapping” algorithms
  - Generates the individual high-level Platform directives to achieve the desired behavior
- Platform Communicator
  - Acts as a proxy for communicating with the Platforms (one per Platform)
  - Converts ASF high-level directives from the Fleet Manager to domain specific “machine” commands
  - Responds to requests for Platform science/status
    - Supports “one-time” or “interval” requests
    - Communicates directly with the Platform for “live” data
    - Supplies interpolated data if Platform connection cannot be obtained (includes a “degree of confidence”)

Functional Architecture (cont.)

- Fleet
  - An abstract collection of Platforms that are to be used to satisfy the goal requirements
  - Platforms can be heterogeneous, i.e. surface, airborne, spacecraft, etc.
- Platform
  - Represents a physical entity that houses any number of sensors to measure environmental attributes
  - Can have any level of autonomy
  - Must provide a defined way of remote communication with the Platform Communicator to:
    - Supply requested information:
      - Sensor values
      - Status
    - Optionally be commanded to move to another location
- Simulator
  - Simulates all Platform capabilities including communication with the Platform Communicator
  - Supplies simulated environmental data using domain specific environmental models, i.e. Regional Oceanic Modeling System (ROMS)

Project Information
Schedule



Project Information
Implementation Plan Summary

- **Phase A** will demonstrate basic collaborative multi-platform region and feature mapping based upon high-level goal definition in a simulated environment.
  - Step 1 (May 31, 2004)
    - A primary focus on system architecture implementation
    - Simple goal definition (requires integration with SGM web interface),
    - Ability to send basic calculated directives to the Platform Simulator to perform waypoint navigation
    - Display the craft positions on a navigational chart (requires integration with IRC)
  - Step 2 (July 31, 2004)
    - Enhanced goal definition (includes interpretation of Navigation Charts from NOAA),
    - Receive in-situ science measurements and positional data from the Platform Simulator,
    - Perform improved navigational path planning for the Platforms based upon the capabilities/limitations of the Platforms and some knowledge of the environment
  - Step 3 (September 30, 2004)
    - Perform simulated region and feature mapping based upon the high-level goal definition,
    - Supply three (3) Platforms with waypoints to navigate to the approximate region or feature location using near-optimal path planning,
    - Supply behavior scripts to the platforms for mapping once the destination is reached (or the feature is located), and
    - Monitor in-situ measurements supplied by the craft during simulation.

NOTE: A detailed breakdown of subsystem functions is outlined in the Project Schedule/Implementation Plan

Project Information
Phase A Objectives

- Objectives for Phase A
  - Demonstration of both Dynamic Region Mapping and Feature Mapping in a ***simulated*** environment
  - Perform collaborative science measuring using multiple Platforms in a ***simulated*** environment
    - Collaboration is obtained by collecting the in-situ Platform measurements, and making adjustments to all Platforms based upon those measurements
    - Minimum of three (3) simulated Platforms
  - Support goal definition and submittal for both demonstrations

Project Information
Phase B Objectives

- Objectives for Phase B
  - Demonstration of both Dynamic Region Mapping and Feature Mapping in a ***physical*** environment
  - Perform collaborative science measuring using multiple Platforms in a ***physical*** environment
    - Dye will be placed into the water at a designated location (near Wallops) under a controlled setting.
    - Minimum of three (3) simulated Platforms
  - Support goal definition and submittal for both demonstrations

Current Work

- Finalizing the Initial System Design
  - Addressing RIDs from the High-Level Design Review
  - Subsystem Interface Details
  - Holding Subsystem Design Walkthroughs
- Starting Implementation

Project Information

Project Documentation:

- ISO 9001 Product Development Plan/Customer Agreement
- Requirements Document/Mapping to Design
- Use Case Scenarios
- Design Document (in progress)/Presentation
- Project Schedule/Deliverables/Implementation Plan
- RIDS from Prior Requirements Review(s)

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